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A MULTISPECIES HOUSEHOLD PRODUCTION ANALYSIS OF RECREATIONAL FISHING WITH DISPOSITIONAL BENEFITS

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The most common management measures for recreational fisheries involve controls on number of fish landed by species, fish size, and number of fishing trips. Previous studies in recreational fishing do not combine all these policy variables to evaluate their interdependency in the recreationalist's consumption decision. Furthermore, previous studies, which attempt to estimate the marginal valuation of fishery resources used in recreation, do not recognize the commercial or subsistence benefits generated when the recreational catch is sold or kept for home consumption. This can lead to misinterpretations of the value estimates placed on the resource and of the estimated behavior in recreational fisheries. In the present study the theory of household production is applied to recreational fishing to include each of the most common policy variables. The results of this application in the conceptual model show that the usual interpretations of recreational resource values are altered when use of the resource also involves commercial or subsistence activities. Except in catch-and-release fisheries, these dispositional benefits are usually present.

The theory of household production applied in the next section represents a new interpretation of consumer choice theory developed by Becker, Lancaster, and Muth. Simply put, households combine goods and time to produce final commodities for consumption. In recreational fishing, certain attributes are used to describe the activity. This approach contains a more complete framework to impute values directly to the fishery resource and analyze the consumption behavior in the recreational activity. Shortcomings of the travel-cost and direct-interview methods of estimating resource values are discussed by Cocheba and Langford. Hammack and Brown develop a greatly improved method of resource valuation based on an extension of the direct interview approach which has much in common with the household production approach used in the present paper. However, their model does not recognize the interdependency between policy variables since resource demand functions are estimated by imposing a priori restrictions in the empirical model. Also, they do not consider dispositional benefits in their interpretation of the results.

The developed household production model for recreational fishing is tested using a two-step hedonic procedure. Rosen develops the procedure by combining the theory of household production with the practice of adjusting price indexes for quality changes in goods (Griliches). Brown, Charbonneau and Hay use the procedure in a study of fish and wildlife recreational resources. But they do not evaluate the interdependency between species captured. Also, the important policy variable of animal size was not available in their data for analysis, nor did they interpret their results with due considerations for dispositional benefits.

The present study, then, extends the previous work in outdoor recreation by showing the impact of dispositional benefits on the marginal valuation of recreational resources in a conceptual model; estimating the demand for a fishery resource when it is measured in fish size as well as number of fish; and, in demand, estimating interspecies relationships for a multispecies fishery. Finally, these results are used to assess changes in welfare for policy measures which affect catch rates by species. The results may also be used to assess policies changing the mean fish size of the catch and the annual number of household boating trips.

Conceptual Model

"Pure Sport" Model of Recreational Boating and Fishing

A commodity in household production theory is analyzed as being characterized by a bundle of attributes. The attributes embodied in a boating activity, B, are total number of fish landed, c, mean size of the fish landed, s^c, number of boating trips with participation in a fishery, t^r, and number of boating trips which do not involve fishing, t^g. Expressing the boating commodity as a function of its attributes we have

$$B = B(c,\ s^c,\ t^r,\ t^g)\ . \tag{1}$$

Each boating commodity is differentiated by the combination of attributes given in equation (1). The combinations of attributes are sufficiently large for the household choice among the alternative boating commodities to be continuous. However, there may exist some constraints that limit the feasible set of attribute combinations. For example, it is not technically feasible in the model to land fish without taking a fishing trip. However, within the feasible set of boating commodities a sufficiently large number of combinations of c and t^r exist for the choice to be continuous. This assumption implies that the catch per trip will vary between households. A further assumption is that the household consumes only one type of boating commodity and commits itself to the choice at the beginning of the fishing season. Since the boating commodity is differentiated by the attributes, the amount households pay for the commodity is influenced by the attributes.

$$(2) \qquad P = P(B) = P(c,\ s^c,\ t^r,\ t^g)\ .$$

Total expenditures for the boating activity, P, are expressed as a function of the same attributes which characterize the activity.

The household consumption decision is formulated by considering a well behaved utility function,

$$(3) \qquad U = U(x,\ B)$$

where x is all other goods. It is assumed that the marginal rate of substitution between any pair of boating attributes is functionally independent of x. Substituting for B, the utility function then is rewritten as

$$(4) \qquad U = U(x,\ c,\ s^c,\ t^r,\ t^g)\ .$$

The budget constraint is developed from money-time resources available to the household and money-time expenditures. Income, y, is equal to the product of work time, t^w, and wage rate, w.

$$(5) \qquad y = t^w w\ .$$

Total available time, t, is equal to the sum of work time, other household activity time, t^x, and the two components of boating time.

$$(6) \qquad t = t^w + t^x + t^r + t^g\ .$$

Solving for t^w in equation (6), substituting into equation (5) and rearranging yields the money-time resource or full income.

$$tw = y + t^x w + t^r w + t^g w \,. \tag{7}$$

Full income, as developed in the context of household production by Becker, represents the money income if all available time were devoted to work. Equation (7) describes one basic resource since household production theory highlights the tradeoffs between time and goods in the production of final commodities. On the expenditure side of the household budget constraint the total money and time costs, E, of all inputs to produce x and B are

$$E = x + P(B) \tag{8}$$

where the price of x is one and only one unit of B is consumed. Equating the household's resources, tw, in equation (7) with expenditures, E, in equation (8) yields the household budget constraint

$$y + t^x w + t^r w + t^g w = x + P(B) \,. \tag{9}$$

This constraint states that total money and time resources available to the household are expended on the goods and time required to obtain final household commodities.[1]

Footnote 1

Assuming a competitive implicit market exists for each boating attribute and each market is in equilibrium, then the implicit price for an attribute is measured by the first derivative of P(B) in equation (2) with respect to the attributes (Rosen). The following interpretations of the implicit prices for the boating attributes are developed from the first order conditions for maximizing equation (4) subject to equation (9) where λ is the Lagrange multiplier. (Subscripts indicate derivatives.)

(10) $$P_c = \frac{U_c}{U_x} = \frac{1}{\lambda}(U_c)$$

(11) $$P_{s^c} = \frac{U_{s^c}}{U_x} = \frac{1}{\lambda}(U_{s^c})$$

(12) $$P_{t^r} = \frac{U_{t^r}}{U_x} + w$$

(13) $$P_{t^g} = \frac{U_{t^g}}{U_x} + w$$

In this initial model the household makes no other use of the fish resource except in the game of capture. Therefore in equations (10) and (11) a necessary condition for utility maximization is that the household adjusts c and s^c until its willingness to pay for these qualities of the fishery resource are equated to the rate at which the household is willing to substitute x for c and s^c in recreation alone. In equations (12) and (13) the implicit price of a fishing trip or simple boating trip which does not involve fishing is equal to the sum of the necessary marginal sacrifice of other commodities plus the necessary forgone earnings.

Implicit Prices with Further Use of the Recreational Catch

Fish, like certain types of hunted game, is a unique recreational resource since it may yield benefits as a food source as well as an input to a recreational activity. The recreationally caught fish are at the household's disposition for either release, home consumption or sale. I refer to the increase in an attribute's implicit price generated by commercial sales or subsistence use of the catch as dispositional benefits. By including the various uses of the fishery resource in the model, the need to select arbitrary definitions for recreational, subsistence, and commercial fisheries becomes unnecessary for analytical purposes. The household considers both recreational and dispositional benefits in its consumption decision. In some fisheries the disposition of catch is used as a management measure. Catch and release fisheries preclude the subsistence or commercial use of the resource. In such fisheries the recreational activity is commonly referred to as a "pure sport"--the absence of non-recreational motivations is one interpretation of the term. In other fisheries commercial sales are prohibited but landing the fish for home consumption is allowed.

Reconsider the household utility function in equation (3) rewritten with, f, the number of fish consumed.

$$U = U(x, f, B) \tag{14}$$

Food fish for home consumption may be purchased at $p(s^f)$ per fish which depends on the size of the market fish, s^f, selected by the household. Fish for home consumption may also be obtained from the household's recreational catch in the course of the boating activity. The recreational catch can alternatively be sold at $p(s^c)$ per fish which will vary by fish size. With this information the budget constraint in equation (9) may be rewritten as

$$y + t^x w + t^r w + t^g w + t^f w + p(s^c)\, c = x + P(B) + p(s^f)\, f \tag{15}$$

The new terms on the left side, $t^f w$ (t^f is the time devoted to fish consumption) and $p(s^c)c$, represent the reallocation of time in full income and the supplement to money income, respectively. Money income is supplemented by $p(s^c)c$ if the catch is sold or if it is kept for home consumption. This assumes no price differential between the ex-vessel and retail levels. Therefore, when s^c equals s^f, as in a subsistence fishery, $p(s^c)$ equals $p(s^f)$. Finally, the new term on the right side of equation (15), $p(s^f)f$, represents the expenditure for food fish.

New implicit prices are derived for the fishery resource from the first-order conditions for maximizing (14) subject to (15) now that disposition of the catch has been introduced into the model. When the catch is commercially sold the equilibrium prices are

(16) $$P_c = \frac{U_c}{U_x} + p(s^c)$$

(17) $$P_{s^c} = \frac{U_{s^c}}{U_x} + \frac{\partial p(s^c)}{\partial s^c} c \; .$$

The price for each measure of the fishery resource is equal to the respective price in the pure sport fishery (equations (10) and (11)) plus marginal revenue. For number of fish marginal revenue is the price per fish . For fish size it is the change in the price per fish with respect to fish size multiplied by the total number of fish landed. The larger the catch the greater are the potential benefits of an increase in fish size. When c is greater than zero, marginal revenue is typically greater than zero since the absolute yield from a fish increases with fish size. However, the price per fish will fall if the commercial price per pound is discounted sufficiently for larger fish.

The implicit prices are expressed differently when the catch is kept for home consumption as in a subsistence fishery. The monetary equivalent of a marginal unit of utility is $1/\lambda$ which may be written as

$$\frac{1}{\lambda} = \frac{1}{U_x} = \frac{p(s^f)}{U_f} \tag{18}$$

from the first order conditions. Under the conditions of a subsistence fishery discussed above and substituting from equation (18), the implicit prices are rewritten as

$$P_c = \frac{1}{\lambda}(U_c + U_f) \tag{19}$$

$$P_{s^c} = \frac{1}{\lambda}\left(U_{s^c} + U_f \frac{\partial p(s^c)}{\partial s^c} \Big/ p(s^c)\ c\right). \tag{20}$$

These results show that in a subsistence fishery the household is in equilibrium when it is willing to pay the monetary equivalent of the summation of marginal utilities of fish in recreational activities and food consumption. For the fish size attribute the marginal utility of fish in subsistence is weighted by the relative change in fish price with respect

Footnote 2 to fish size and number of fish landed.[2]

Typically, then, with the possible exceptions noted, the implicit prices for number of fish landed and fish size will be greater when further use of the catch is permitted. In the presence of dispositional benefits, the marginal valuation of the fishery resource should be associated with the commercial or subsistence use of the resource as well as the recreational

Table 1 use. Table 1 summarizes these results of the household production model.

Application of the Implicit Prices

The household production model for recreational boating is operationalized by use of Rosen's hedonic pricing technique. The procedure follows two steps with assumptions consistent with the above model. The first step as described in the previous section requires the estimation of P(B)--regress total money and time expenditures for the annual boating commodity on the boating characteristics, c, s^c, t^r, and t^g. The specification and choice of functional form for P(B) should serve to duplicate the information acquired by households in their decision making process. Next, calculate the implicit price of each boating attribute by taking the first derivative of P(B) evaluated at the attribute level for each household. In the second step, the estimated implicit prices are used to estimate the demand for fishing attributes in the same way direct observations on prices are used.

Empirical Model and Results

A survey was conducted in Kailua-Kona, Hawaii during 1977. Information is used from 144 households out of a random sample of 450 registered vessel owners. Households were deleted for at least one of the following reasons: Respondent could not be reached; respondent does not fish for relevant species; respondent refused interview; respondent is a commercial fisherman and derives 100% of income from fishing; survey questionnaire not complete; or vessel is used for chartering. Most households have a head of household with a full-time job not related to fishing. Ground transportation costs to the recreational site are not an important factor as in many outdoor recreational studies since households reside at the site.

The Hedonic Price Function

Consistent with the conceptual model, the households surveyed are engaged in a household boating activity composed of number of fish caught, fish size, and different types of boating trips. For purposes of analysis it is desirable to disaggregate the catch into different species. A multispecies analysis recognizes that households in this particular fishery possess some discretion as to which species they catch. This is controlled, in part, by area fished and type of fishing tackle used. Fishermen may also determine what size of fish they catch by choice of vessel and other type of equipment. However, such decisions about size will affect the size of all species caught. Therefore the size attribute is for the aggregate catch rather than by species. In the first-step

Footnote 3 analysis the hedonic price function P(B) is initially specified in the form[3]

$$P = \alpha + \sum_{i=1}^{6} \beta_i B_i + \sum_{j=1}^{5} \sum_{i=1}^{5} \gamma_{ij} B_i B_j + e \tag{21}$$

where

P = total annual expenditures for goods and time inputs to the boating commodity;

α, β_i, and γ_{ij} are parameters to be estimated;

B_1 = BILL = annual number of billfish landed such as blue marlin, black marlin, striped marlin, spearfish, and sailfish;

B_2 = GAME = annual number of other gamefish landed such as mahimahi and wahoo;

B_3 = TUNA = annual number of tuna landed such as skipjack tuna and yellowfin tuna;

B_4 = SIZE = mean size of fish in pounds for total fish landed;

B_5 = FTRIP = annual number of fishing day trips;

B_6 = NFTRIPS = annual number of boating day trips which do not involve fishing; and

e is a random error term.

As Rosen explains, actual specification of equation (21) should serve to capture as much of the systematic information available in the data--information used by households in their household production and consumption decisions. To accomplish this, subsets of the data were investigated to evaluate if different groups of households made use of different types of information in their household decision. The households are stratified into three groups by how many years they have participated in boating with their current vessel. The three groups are identified as new (one full year or less), intermediate and established (four years or more). The model specification differs for each group and follows one method suggested by Theil and used in other hedonic pricing models (Witte, Sumka and Erekson). For each group, those variables in equation (20) with a t-ratio of less than one are dropped with consideration for joint signifi-

Table 2 cance. The results in table 2, using ordinary least squares, reflect this choice. The results are interpreted by taking the first derivative of equation (20) for each attribute to calculate implicit prices for each of the 114 households. The mean implicit price for increasing the catch by one fish is \$140 for a billfish, \$30 for other gamefish, and \$18 for an additional tuna. If the average fish landed weighed one additional pound, the household would pay \$11 for the marginal increase in total pounds landed. The prices for each species of fish and fish size are reasonable estimates given the interpretation of the implicit prices developed in the

Footnote 4 household production model.[4] The implicit price for one additional boating trip is \$122 if the trip involves fishing. The estimated price for a non-fishing trip is \$51, but it is assumed that an implicit market does not exist for this attribute. Over 95% of the boating trips involve fishing, therefore in the second-step analysis markets are only described for the five fishing attributes. These results show that the value of a fishery can be measured in different ways--the value of the resource in number of fish or fish size and the value fishermen place on a fishing day-trip, holding other attributes constant.

The Demand for Fishing Attributes

In the second-step analysis the estimated implicit prices are used to estimate the demand function for each fishing attribute. The demand function for the i^{th} attribute is

(22) $$P_i = P_i(B_1, \ldots, B_i, \ldots, B_5, \text{NFTRIP}, \text{INC}, \text{AGE})$$

where the B_i's and NFTRIP are as defined previously, INC is annual household income in \$1,000 and AGE is age of the head of household. The demand functions are estimated using ordinary least squares. The parameter estimates are subject to bias due to simultaneous changes in attributes and shifts in supply caused by differences in costs or expertise in fishing across households. Cost differences may be measured by access to better information about fishing conditions through angling clubs, whether the vessel is trailered to a launch site or moored, the number of passengers the vessel is designed to accommodate, familiarity with fishing methods, and the fisherman's familiarity with the fishing grounds. The results of the second-

Table 3 step analysis are summarized in table 3.

Price and quantity are inversely related in demand for four out of five fishing attributes.[5] The marginal implicit price of billfish is not affected by incremental changes in the billfish catch, holding other things constant. The marginal valuation of gamefish decreases about $6 for an increase of one gamefish while the marginal implicit price for tuna decreases only about $1 for an increase of one tuna. If the size of each landed fish increases on the average of 1 pound then the willingness to pay for fish size would decrease about $0.61. The marginal implicit price for a fishing trip will fall about $1 if the household takes one additional trip.

Footnote 5

A point of interest in a multispecies analysis is the interaction between species. If species are determined to be biologically independent, piecemeal steps are usually taken to manage each species. However, the implicit markets for the species may be interrelated as the results here indicate. Four out of the six coefficients are significantly different from zero showing that the species in this fishery can be either substitutes or complements for each other in consumption. Tuna and other gamefish are substitutes since an increase in the number of gamefish causes the implicit price of tuna to fall. The results of the theoretical model indicate that the substitution between these two species can be explained by more than just substitutes in the demand for recreational fishing. The results may also reflect substitution of the species in commercial sales or in food consumption, as in the case of a subsistence fishery. The results also indicate that billfish and gamefish are complements in demand. But this is qualified by the possible correlation of these attributes in supply--even though we assume in the model that a sufficiently large combination of species is available to the household for the choice to be continuous. A second complementary relationship exists between billfish and tuna. An increase in number of billfish landed increases the demand for tuna. A priori, there are stronger reasons to expect the interspecies relationship to reflect substitution, as between tuna and other gamefish, or independence rather than reflect a complement relationship. However, there are two possible activities which may explain part of the apparently anomolous result of billfish being a complement good for tuna. First, the smaller tuna are sometimes used as live bait for billfish so that part of the demand for tuna may be derived from the demand for billfish. The practice of using the tuna catch for billfish bait does not seem so prevalent, though, that the two products should be identified as joint products in production. But the activity may influence the estimated complementary relationship. Secondly, commercial buyers of the recreational catch deal mostly in tuna. Fishermen who want to sell their billfish catch may find it less costly to find a buyer and more rewarding in price if they can sell tuna to the buyer also. There is no evidence of such tying sales, but scattered instances of this practice may also explain part of the estimated complementary relationship.

Holding catch by species constant the marginal valuation of billfish and gamefish are affected in different ways by a change in the mean fish size. An increase in the mean fish size prompts the household to place a higher marginal value on a billfish. This follows from the trophy value placed on larger billfish in recreation. For example, a 1 pound increase would prompt fishermen to be willing to pay about $4 more for a billfish. But a marginal increase in the mean fish size causes a fall in the demand for fish size. This could be explained, in part, by the desire of households to land a given quantity of gamefish in pounds. Therefore, if the household is able to land more gamefish (or tuna) in number, then it is not willing to pay as much for a marginal improvement in fish size.

Fish size clearly serves as an important determinant of demand for fishing trips. As the size of the total catch increases, the marginal valuation of a fishing trip increases. And it also holds that the more active the household is in the fishery, as measured by the annual number of fishing trips, the more the household is willing to pay for an increase in fish size.

As one might expect, total catch of gamefish and total catch of tuna are complements with fishing trips. This is evident in the demand functions for gamefish and tuna, and in the demand function for fishing trips. However, fishing trips and billfish catch are substitutes in consumption. This result indicates that households taking fewer trips per year are willing to pay more to catch and land a billfish than households which fish more often.

The remaining independent variables, non-fishing trips, income, and age, are significantly different from zero in four instances. The more non-fishing trips a household takes during the year the less it is willing to pay for a marginal improvement in fish size. An increase in income increases the demand for fishing trips but decreases the demand for tuna. The revenue from tuna sales and the use of tuna for home consumption represent important supplements to money income for the lower income groups in the survey. It is likely that as income increases these households substitute away from tuna to both other types of recreation and other sources of food. Age is inversely related to the demand for fishing trips. This concludes a description of the consumption behavior in the fishery. The following section demonstrates the different ways these results can be used to assess policy issues.

Consumer's Surplus

Measures of consumer's surplus for a household may be approximated from the estimated demand curves to assess the gains or losses in welfare associated with alternative public policies. Suppose, for example, a policy increases the catch rate for a particular species, reduces costs and results in a 10% increase in the economic equilibrium total catch for that species. The resulting incremental increase in consumer's surplus in the implicit market for that species represents the gain to households if supplies are sufficiently elastic in the other attribute markets for other prices not to be affected. The gain associated with billfish, other
Footnote 6 gamefish and tuna, individually, is $11, $82, and $72, respectively.[6] Other policy measures which influence the mean fish size or annual number of fishing trips can be evaluated in the same manner. If supplies are less elastic in the other markets, then the full assessment of the gain (or loss) would depend on the supply curves in those markets as well as the demand curves.

Summary and Conclusion

The theory of household production serves as a framework to evaluate implicit markets and assess welfare implications of policy measures in outdoor recreation. In recreational fisheries each of the most common policy variables are incorporated into a household production model of a boating activity. The activity is characterized by number of fish landed by species, fish size, number of fishing trips, and number of non-fishing trips. From the results of the conceptual model it is concluded that the marginal valuation of the fishery resource depends on how the resource is measured (number of fish landed and fish size) as well as the disposition of the catch (release, commercial sales or subsistence). These findings extend previous recreational fishing studies which assume fish size does not generate recreational benefits independent of the quantity of fish landed. Furthermore, the findings extend previous studies in outdoor recreation relevant to resource valuation which do not explicitly recognize the impact of dispositional benefits in the consumption decision. Fishermen consider all associated benefits derived from the fishery resource. The interpretations of the estimated marginal values for the boating attributes and interaction between policy variables in household consumption behavior should reflect the commercial and subsistence use of the recreational resource.

The implicit prices estimated for billfish, other gamefish, and tuna in a Hawaii fishery represent the marginal value placed on these species in recreation, commercial sales, and subsistence fishing combined. The implicit price estimated for fish size also represents the dispositional use of the catch as well as recreational use. Using these prices with the estimated price for fishing trips to analyze the implicit demand for each attribute, the interactions between policy variables are described. The interspecies behavior is described by the substitute or complement relationship between species in demand. Again, the empirical results are interpreted with the findings of the conceptual model. The interaction between species is explained by how they are combined in recreational demand as well as how they are combined in commercial sales and food consumption by the household. The substitution or complementary relationship between catch by species and fish size is explained by the same type of factors. Fish size also interacts with number of fishing trips. The larger the fish size the greater the demand for fishing trips; and conversely, the more a household participates in a fishery the more it is willing to pay for a marginal improvement in fish size. Finally, from the results it is concluded that for certain species the household substitutes between annual catch and annual number of trips. In the case of billfish, households which take fewer trips are willing to pay more for a billfish catch. But households which take more trips are only willing to pay more for other gamefish and tuna catches, reflecting the complementary relationship between these policy variables. The estimated demand curves for each policy variable may be used to assess the welfare implications for different policy schemes. Application of the results for this purpose is demonstrated for policies which increase the catch rates and thus reduce the cost of landing a fish.

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Footnotes

[1]The full income concept used in household production theory appears to be at odds with studies which conclude that the use of the wage rate for the cost of time is inappropriate. These studies analyze the value of travel time in the estimation of recreation benefits (see Cesario for such an analysis and a discussion of other studies). The conflict does not occur in the present study. Travel time is minimal for the participants of the particular fishery analyzed in the empirical section of this paper since they live at the recreation site. Also, it is observed that participants take off work time occasionally to engage in the fishing activity.

[2]Many occupations are recognized for providing non-pecuniary income to workers. If this is the case for a commercial fisherman then the above results show that the marginal valuation of the number of fish landed is understated by the commercial market price. The difference between the full marginal valuation and pecuniary income is the monetary equivalent of the marginal utility of landing a commercial fish or non-pecuniary income. From equations (16) and (18),

$$P_c - p(s^c) = \frac{1}{\lambda}(U_c) .$$

[3]This functional form does not impose a priori constraints on the second derivatives of the equation. Witte, Sumka, and Erekson show that semilog and log linear functional forms used in the first-step analysis of estimating the hedonic price function (common forms used in hedonic price studies) introduce severe bias into the second-step analysis of estimating

demand functions. A negative relationship is imposed between the estimated implicit price derived from the first-step and the respective attribute quantity regardless of the existence of an implicit market and regardless of the underlying economic behavior.

[4]As discussed in the conceptual model, these marginal value estimates are generated by recreational and dispositional benefits. However, resource values may also be composed of non-consumptive benefits (Cocheba and Langford) and existence benefits (Miller and Menz). Whether these additional benefits are embodied in the above marginal value estimates depends on how these additional uses of the resource are separable from the boating commodity in the utility function.

[5]Coefficients are significantly different from zero at the 0.10 level, two-tail test.

[6]If the demand curves are estimated under the restrictions of symmetrical cross-price terms, then the approximations of the gain are \$15, \$91, and \$103, respectively.

Table 1. Summary of Implicit Prices with Alternative Uses for the Fishery Resource

Boating Attribute		Implicit Price		
		"Pure Sport" Case	With Additional Use of the Fishery Resource	
			Commercial	Subsistence
Number of fish caught (c)	P_c:	$\frac{U_c}{U_x} = \frac{1}{\lambda}(U_c)$	$\frac{U_c}{U_x} + p(s^c)$	$\frac{1}{\lambda}(U_c + U_f)$
Mean fish size (s^c)	P_{s^c}:	$\frac{U_{s^c}}{U_x} = \frac{1}{\lambda}(U_{s^c})$	$\frac{U_{s^c}}{U_x} + \frac{\partial p(s^c)}{\partial s^c}\, c$	$\frac{1}{\lambda}\left(U_{s^c} + U_f\left(\frac{\partial p(s^c)}{\partial s^c} \Big/ p(s^c)\right) c\right)$
Fishing trip (t^r)	P_{t^r}:	$\frac{U_{t^r}}{U_x} + w$		
Non-fishing trip (t^g)	P_{t^g}:	$\frac{U_{t^g}}{U_x} + w$		

Table 2. Summary Results of First-Step Analysis--Estimating P(B)

Group	Constant	B_1[a]	B_2[b]	B_3[c]	B_4[d]	B_5[e]	B_6[f]	B_1^2	B_2^2
	Independent Variables								
New	-2,060.23 (1,053.00)[g]	-898.36 (447.81)	411.50 (129.06)		38.78 (22.35)	199.26 (48.31)	234.18 (86.51)		-20.14 (6.16)
Intermediate	3,156.42 (1,064.70)						-169.12 (105.54)	-52.44 (52.84)	-0.36 (0.64)
Established	1,605.65 (762.69)	(1,067.24) (1,098.71)		-4.44 (40.13)			92.42 (85.39)	-61.29 (216.35)	

Group	B_3^2	B_4^2	B_5^2	B_1B_2	B_1B_3	B_1B_4	B_1B_5	B_2B_3	B_2B_4
New	-0.94 (0.47)	-0.42 (0.18)	-1.98 (0.47)	65.88 (13.01)		15.68 (3.43)	-33.32 (8.76)		-5.77 (1.58)
Intermediate		-0.45 (0.26)	-0.30 (0.75)	50.17 (33.64)					
Established	-0.33 (0.26)				-4.28 (8.79)	-5.42 (17.45)		-0.32 (0.40)	

Group	B_2B_5	B_3B_4	B_3B_5	B_4B_5	n	R^2	F
New	5.22 (2.49)		2.89 (0.83)	1.15 (0.59)	39	0.93	19.37
Intermediate		-1.32 (0.59)	0.57 (0.42)	2.94 (0.89)	39	0.82	12.55
Established			1.79 (0.89)	0.88 (0.48)	36	0.72	6.59

[a]Number of billfish landed. [b]Number of other gamefish landed. [c]Number of tuna landed. [d]Mean fish size of total catch in pounds. [e]Number of fishing day trips. [f]Number of non-fishing day trips. [g]Standard error in parentheses.

Table 3. Summary Results for Second-Step Analysis--Estimating the Demand Functions for Fishing Attributes[a]

Implicit Price	Independent Variables									R^2	F
	Constant	BILL	GAME	TUNA	SIZE	FTRIP	NFTRIP	INC	AGE		
P_{BILL}	-57.65 (344.32)[b]	-35.89 (29.08)	16.85*** (5.97)	1.53 (2.29)	4.35* (2.43)	-11.34*** (3.32)	10.70 (17.03)	-59.53 (106.82)	6.12 (5.88)	0.17	2.69
P_{GAME}	12.14 (80.95)	41.46*** (6.84)	-6.50*** (1.40)	-0.61 (0.54)	-2.32*** (0.57)	1.55* (0.78)	-3.97 (4.00)	23.14 (25.11)	1.31 (1.38)	0.37	7.85
P_{TUNA}	30.23 (21.17)	3.10* (1.79)	-0.70* (0.37)	-0.68*** (0.14)	-0.21 (0.15)	1.78*** (0.20)	-0.65 (1.05)	-21.48*** (6.57)	-0.12 (0.36)	0.53	14.71
P_{SIZE}	-13.57 (17.70)	9.41*** (1.50)	-0.76** (0.31)	-0.72*** (0.12)	-0.61*** (0.12)	1.50*** (0.17)	-1.67* (0.88)	3.29 (5.49)	0.35 (0.30)	0.59	18.66
P_{FTRIP}	83.21** (37.78)	-28.36*** (3.19)	2.01*** (0.65)	1.27*** (0.25)	1.67*** (0.27)	-1.03*** (0.37)	0.74 (1.87)	30.31** (11.72)	-1.28* (0.65)	0.50	13.15

[a] 114 observations.

[b] Standard error in parentheses.

*Coefficient is significant at 0.10 level, two-tail test.

**Coefficient is significant at 0.05 level, two-tail test.

***Coefficient is significant at 0.01 level, two-tail test.